Exploring the implementation of standardized processes in a professional setting

Authors

Marianna MARIANNA Frangeskou, U. of tilburg, m.frangeskou@uvt.nl
Michael Lewis, School of Management, U. of Bath, M.A.Lewis@bath.ac.uk
Christos Vasilakis, U. of Bath, c.vasilakis@bath.ac.uk

Marianna MARIANNA Frangeskou, U. of tilburg, m.frangeskou@uvt.nl
Michael Lewis, Christos Vasilakis

Exploring the implementation of standardized processes in a professional setting: The case of implementing a clinical care pathway

Abstract

In this study, we investigate the process of standardising people-centric, knowledge-intensive, professional work, specifically attempts to adopt a common standard for hospital stroke care. In operations management (OM), standardization (i.e. eliminating various aspects of process variation) is central to increased control but in professional work, managerial influence is more limited because (medical) professionals deploying specialized knowledge enjoy, by definition, significant autonomy. The research is built upon an in-depth longitudinal case study in a UK hospital that confirms the value of standardization in healthcare work but also strongly emphasizes that it must be understood as a multi-dimensional puzzle. The findings confirm established but under-developed, insights regarding limitations of the dominant OM process design logic, namely flow dependency. Our analysis clearly shows that variation is also driven by sharing (i.e. sub-optimal layouts, high-utilisation and high-variability of resources) and fit (i.e. conflicting KPIs) dependency considerations. More specifically, we observed – often via the use of shared (or not) pathway artefacts (maps, etc.) - that autonomy has negative and positive impacts on inter-professional collaboration. Autonomy frequently led to minimally shared mental models of care, perspectives on the best interests of the patient, etc. and (often highly dysfunctional) competition between individuals and groups. Where we observed effective inter-professional collaboration, it had been achieved through relational resources (i.e. shared goals, interests etc.) developed via continuous interaction and knowledge sharing mechanisms. However, pathway capacity issues (i.e. staff and bed availability, etc) moderated such interactions. The paper concludes by discussing how these insights can help healthcare operations managers and other professionals to design better process and implementation strategies that improve the delivery of care.

Keywords: Professional autonomy, Standardised processes, Healthcare

INTRODUCTION

In this study, we investigate the process of standardising people-centric, knowledge-intensive, professional work, specifically the attempts to adopt a common standard for hospital stroke care. The motivation for this study arises from the tension at the heart of all operations, which employ professionals: professional people affect structures, because they have independent, externally enforced standards to which the operation must adjust. However, at the same time, operations work based on more or less formalised routines, processes and systems, which can inhibit professional autonomy (and processes of professionalization).

In this paper, we seek to explore this tension by investigating the challenge of work standardization in a medical professional work environment. Healthcare systems, and hospitals in particular, are facing significant sustained pressure to improve their effectiveness and efficiency (Ponsignon, Maull, & Smart, 2014; Tucker, 2007), which resulted in repeated attempts to transfer 'industrial' OM methods to medical settings (Cottyn, Van Landeghem, Stockman, & Derammelaere, 2011; Dassisti, 2010). Yet despite the apparent benefits of Healthcare OM (Brown, Tucker, & Domokos, 2003; McDermott & Stock, 2007), implementation regularly fails (Victor, Boynton, & Stephens-Jahng, 2000). One possible explanation for this 'implementation gap' is a failure on the part of practice and scholarship to sufficiently recognize the broadly people-centric, and specifically the professional-centric, nature of healthcare (Dobrzykowski, McFadden, & Vonderembse, 2016).

The elimination of variability via standardization of work is a fundamental tenant of OM, whereby employees should follow pre-determined standards in carrying out work tasks (Lillrank & Liukko, 2004). However, in a hospital setting where medical professionals carry out much of the work, standardization may not be associated with improvement but rather with the notions of sameness, uniformity, and even suppression (Timmermans & Epstein, 2010). A professional medical

workforce is characterised by a high degree of knowledge specialisation and autonomy (Abbott, 1981). By virtue of control of their specialised knowledge, professionals are given ultimate authority over their work practice (Nembhard et al. 2009) to make decisions independently and decide the principles of their own work activities (Freidson, 2001). Therefore, this characteristic of professional work, freedom to make decisions without interference (Abbott 1981) is in opposition to the nature of standardization, which by definition limits such freedom. Moreover, the interactions between diverse professionals involved in delivery of healthcare suggest boundaries and dependencies with a different character to the core ideas of flow and balance that are discussed in OM (Smart, Maddern, & Maull, 2009).

While, some researchers have recognised the importance of studying processes systemically (P. A. Smart, 1999; Smart et al., 2009), the majority focus on a single type of dependency. This paper reports on a study that investigated the multi-faceted nature of standardization in a professional work setting, the adoption of a nationally standardised acute stroke care pathway. Care pathways are interdisciplinary care plans that summarise the optimal sequencing and timing of interventions for patients with a particular diagnosis, procedure or symptom (Campbell, Hotchkiss, Bradshaw, & Porteous, 1998). In addition to seeking insights regarding a broad(er)-based consideration of fundamental process dependencies by using the Malone et al. (Malone et al., 1999) notions of flow dependency (when one activity produces a resource that is used for a subsequent activity), sharing dependency (when a resource is used for multiple activities), and fit dependency (when multiple activities combine to produce a single resource), this study specifically aims to better understand and characterise the interaction between professionals and standardised processes. Figure 1 summarises the conceptual model of the study.

Insert figure 1 about here

e found the expected (over) emphasis on flow dependency and the consequential lack of consideration of sharing and fit dependency meant that even if a pathway flow was (ex-ante) coherent, when this was implemented (sharing resources with multiple other pathways and treatments) it becomes incoherent. Therefore, ironically, such partial process design insights can themselves create capacity issues – especially when this standard design interacts with emergent resource decisions made by autonomous medical staff. More specifically, we observed that there was some negative and positive effect of the pathway implementation. On one hand pathways can be the vehicle for 'empire building', used to broaden specific professional span of influence and a corresponding sense of increased powerlessness on the part of those who are 'conquered'. But, on the other hand because the formal pathway is a meso construct, i.e. distinct from both the hospital (organization) and the specific professions. This allowed for clarification of role, increased (shared) understanding of personal professional value and, consequently, genuine inter-group communication. That said, it was clear that operations need to 'tread carefully' with the process of formalizing a process. Artefacts (i.e. process representations in documents or software) for example, are not neutral and can exacerbate either of the above dynamics. Specifically, we found that autonomy was associated with minimally shared mental models of care (i.e. shared rules, codes, language etc.), distinct pathway artefacts, diverse perspectives on the best interests of the patient, etc. and (often highly dysfunctional) competition between individuals and groups. Where we observed effective inter-professional collaboration, it had been achieved through relational resources developed via continuous interaction and knowledge sharing mechanisms. However, such interactions were moderated by pathway capacity issues (i.e. staff and bed availability, etc.). The paper concludes by discussing how these insights can help healthcare operations managers and

other professionals to design better process and implementation strategies that improve the delivery of care.

METHODS

In order to investigate the process of standardising knowledge-intensive, professional work, specifically the attempts to adopt a common standard for hospital stroke care, rich multi-faceted data sets were fundamental to gaining insights into complex technical and social processes (Eisenhardt, K.M., Graebner, 2007; Yin, 2014). In selecting a single case study, we could engage insightful analysis because of the opportunity it offers for focus and intensive data gathering (Voss, 2010). Although multiple-case studies can enhance external validity, minimize observer bias, and generate more robust and testable theory compared to a single case research (Eisenhardt, K.M., Graebner, 2007), a single case study was deemed particularly appropriate for this study for three reasons.

First, although standardisation of work processes is under-researched in OM, there is extant theory. As a result, it was essential to undertake both confirmatory, although without formal hypotheses (Smith et al. 2009), and exploratory research pursuing to develop original insight, understanding and enhance the extant theory (Karwan & Markland, 2006). Probing the boundaries of a phenomenon and integrating information from multiple sources (Eisenhardt, K.M., Graebner, 2007) enable researchers to capture the context within which the phenomenon under study occur in much more detail (Voss 2010).

Second, a key aim was to explore the standardisation of professional work within a specific organizational and institutional context. Healthcare professionals are clearly a 'classic' professional type; drawing on a common body of regulated (in this case by nine UK statutory bodies, i.e. General Medical Council) knowledge, values and standards. An in-depth study of a

single setting was important in allowing the researchers to become familiar both with the work itself and the multiple professionals involved in it. None of the researchers were medically qualified, but they had a prior research experience of medical services and had broad contact with the organisational and healthcare studies literature.

Thirdly, the specific setting was chosen because it offers a persuasive example of the challenges associated with standardisation of professional work. Healthcare delivery is a professional service characterized as "complex, customized and reliant upon the knowledge and expertise of the server" (Heineke, 1995). In this environment, connecting dissimilar professionals is useful in achieving high levels of hospital performance (Dobrzykowski & Tarafdar, 2015; "Why does the quality of health care continue to lag? : insights from management research," 2009)). This scene is even more interesting and relevant as hospitals experience pressure to formalize and standardize their activities in order to meet the intensified public control and the need to reduce variation and costs (Goldstein & Naor, 2005), which provided an exemplary setting for answering the research questions.

The case study

A general district hospital in UK was chosen for this work. This hospital provides acute treatment and care for a catchment population of around 500,000 people in a particular city, its surrounding towns and villages. The hospital provides 759 beds and a comprehensive range of acute services including medicine and surgery, services for women and children, accident and emergency services, and diagnostic and clinical support services. The hospital employs over 4,500 staff, some of who also provide outpatient, diagnostic and same-day case surgery services at local community hospitals in the surrounded cities.

Our unit of analysis is the acute stroke care pathway. This is a typical acute medical process, necessitating the convergence of several subsets of activities based on function, space, time and organisational structure. Stroke care is also interesting because performance explicitly has time and cross-functional collaboration components. Given the nature of the stroke condition there is also restricted intervention from either patient or family/friends which allowed us to better isolate dependency and autonomy-related factors. With specific reference to the hospital, the standardised stroke care process with the attached time targets and required resources (based on evidence based medicine) was implemented in 2011. The role of stroke nurse practitioners (SNPs) (explain below) was introduced in March 2015. Before the implementation of the stroke care pathways, stroke patients admitted to the hospital followed the common process of medical assessment and diagnosis (i.e. they did not have their CT scan immediately after admission, but these were first admitted to the Emergency Department (ED until a further diagnosis was made). Although the hospital experienced a huge improvement in the number of patients' length of stay, which was reduced from 18 to 5.5 days and accurate diagnosis of the stroke patients, there was still variations in the process. There were 1144 patients admitted to the hospital with a suspected stroke during the period of this study (01/01/2015-31/07/2017).

Stroke care in the study hospital

Stroke care comprises five distinct sequences of action that must be performed in the right way with appropriate timing. Figure 2 summarises the five key stages of the 'official' stroke care pathway. This diagrammatic representation highlights how the pathway crosses intra-organisational and spatial boundaries.

Insert figure 2 about here

The care process moves through a chronological order from top to the bottom. (1) Patients arrive at the hospital independently or by ambulance. (2) On arrival at the ED, staff should immediately assess the patients and, if diagnosed as emergency stroke patients and judged suitable for thrombolysis treatment (stroke care treatment), they should be transferred immediately for brain imaging (CT scan), otherwise patients should be transferred to an allocated bed in ED, and have their assessment within 20 minutes. (3) All patients should receive their CT scan in the Radiology Department (RD). All the acute stroke patients (thrombolysable) should have their scan immediately, while all the non-acute stroke (non-thrombolysable) patients should have their CT scan within 1 hour of their arrival time. (4) All patients should be transferred back to the ED and receive their medical assessment and treatment if necessary. (5) Patients diagnosed with stroke should be admitted to the acute stroke unit (ASU) where they should receive specialized care. In general, all stroke patients should be admitted to the ASU within 4 hours of their time of arrival at the hospital and within 15 minutes of the time of stroke diagnosis and the admission decision.

Data collection

Our research draws on four data sources - semi-structured interviews, non-participant observations, archival documents and secondary patient data – to create a more solid basis for the analysis (Yin, 2014). The data collection process comprised five different phases, during an 11-month period, from March 2015 to February 2016. In phase one, 15 semi-structured interviews were used to build familiarity with stroke care itself, the care pathway, the key resources and the various professional roles. Using a snowball sampling technique, participants were chosen based on their knowledge and involvement in the stroke care process. The interviews, which lasted 30-45 minutes on average, were loosely structured using a topic guide that covered: ideal stroke care process, causal factors of its variation, and discussions of improvement options. All interviews were recorded and

transcribed. Additionally, formal and informal process documents provided by hospital staff were collected and analysed.

Extensive periods of non-participant observation, 'shadowing' medical staff, in particular the Stroke Nurse Practitioners (SNP) responsible for coordinating and facilitating treatment from the time of arrival in ED until admission to the ASU, were also conducted. In total 192.5 hours of observations and 52 instances of patients following the acute stroke care pathway were documented. As a source of data these have the advantage of providing a live complement to more retrospective interviewee recall of events. It also allows the researcher to note contextual information important to understand delivery of care (Yin, 2014). Field observations took place across several locations, including the ED, the ASU, the radiology department (RD) and the emergency medical assessment unit (MAU).

During the second phase, these data were used to create representations of a generic version of the pathway. This visualisation was then used in the third phase as the basis for conducting a further 8 interviews with medical staff. When more information was needed, we went back to the hospital and undertook further observations. In the fourth phase, we conducted 19 semi-structured interviews using the 'map' developed in phase 3 as the basis for a modified Sequential Incident Technique (SIT). Participants were asked to describe in as much detail as possible any specific incident and these were then coded to unravel variations, irregularities, limitations, bottlenecks, etc. associated with process (Stauss and Weinlich, 1997). The final phase of data collection was a workshop to which we invited all the participants involved in the process. 16 people attended, 9 members of ASU (3 consultants, 3 SNPs, 2 registered nurses and 1 occupational therapist), 7 members of the top management team (head of general medicine, manager of ASU, 3 project managers and the manager of the business intelligence unit). The whole workshop lasted one and

a half hours, with an informal discussion between the researchers and the participants or the process issues and suggestions and ideas for improvement were discussed.

Data Coding and Analysis

All the process observations, contextual notes, transcripts of the interviews, and archival documents were entered into NVIVO and coded. A coding scheme based on the initial conceptual model was developed (see Table A1). NVIVO facilitated the interrogation of the large quantity of data that had been collected, as well as a more thorough analysis presented in the next section., The data set was consisted from: 26979 words of observations, approximately 92500 words of interviews and 198654 words of archival documents, 16 photos and 9 process maps.

After collecting data for the abstract process in the first two data collection phases, to analyse the data and develop the process maps, we used the questions suggested by Spradley (1980).The researcher tried to identify the relationship between the elements in these questions; for instance, the relationship between the activities and the actors or the events and places. This analysis helped the researcher to understand the role of each practitioner in the process, and to develop a sense of how the stroke care routine fitted within the wider context of the organisation. The researcher asked clarifying questions whenever during meetings and observations whenever needed.

After deciding upon the focus of the study and the practicalities of observations scripts and process maps were developed for the ostensive aspect of the process as a whole and for the sub-processes involved in it. In the third phase of the data collection process, the researcher validated the process map (ostensive aspect of the process) through five interviews with the practitioners. After amending the process map in the light of interviews, the process map was used to guide practitioners in the fourth phase, which enabled the researcher to further test its reliability.

Given the large amounts of data being collected, a decision was made to spend 1-2 days every two weeks analysing all of the data thus far collected. Initially two coding schemes were developed, with the aim of answering one main question*: Is there any variation in the process? (a) If yes, what is the issue? (b) What are the factors that cause it?*

One of the coding schemes was used to analyse the data from the interviews, with the second used to analyse the data from the non-participant observations. The researcher searched in the data for keywords such as communication delays, artefacts, and lack of staff competence, trust and others that formed the constituents of the process dependencies based on the literature. After the coding for each dependency was made, the researcher looked on the impact that had on the other dependencies. For example, if a communication issue was observed between the ED staff and the stroke team, this was coded as flow dependency issue that had impact on the availability of resources. And if staff were annoyed or angry about it then a further coding was made for an impact on professionals' relational resources (fit dependency). The coding scheme was reviewed and developed regularly during data collection phase, with theory from the literature used to underpin the developments. This constant interaction with the literature facilitated improved interpretation of the observations data, and also allowed for modifications to codes/categories to the schemes. Eventually the schemes were combined into a single comprehensive scheme including the differences and issues relating to the care process as contained within both the interviews and observations data.

RESULTS

The findings confirm and extend insights regarding the process design logic. Table 1 shows the summary of the number of interviews and observations made of the variation of each process dependency and their interaction.

Flow dependency

Our analysis shows that, in line with classic OM logic, variation from 'standardized work' is driven in part by flow dependency considerations. Flow, especially when it involves coordination of professionals' highly complex and uncertain tasks and operational activities rest on the accurate and timely information exchange between professionals (Dobrzykowski & Tarafdar, 2015; Gittell, 2011) so as to meet quality and safety goals.

Similarly, one of the SNPs added: *"Many times, not having an ED or stroke consultant available with you to assess the patient and make that decision can delay the process. I can assess the patient, but I cannot make the final decision on my own" (SNP2).* In similar cases, SNPs would seek assistance from the ASU doctors, or other ED senior doctors for tasks such as assessing the patient, making a diagnosis, and ordering of medical tests. These practitioners would in turn have to pause their current tasks to assist with the pathway. However, continuous interruptions in the process can lead to lower quality of care since they negatively impact on short-term memory of the actors involved, potentially leading to clinical error (Coiera, Jayasuriya, Hardy, Bannan, & Thorpe, 2002). Interruptions diminish the ability of individuals to recognise a lack of sequence in their actions and the impact of their work on the work of colleagues (Hirsh & Watson, 1996). Thus interruptions introduce both variation to the sequence (i.e. different steps were followed) and to the eventual outcome.

We observed that when medical staff were not competent on stroke care, the decision-making process was delayed since practitioners required more time and resources to carry out their tasks: *"The ED senior doctor today is a very junior registrar and she happens to be excellent, but with limited experience. That is why she asked for my help. If she was on duty during the night and had none to confer with, it would be likely that she would be slower because she would want to consider*

more factors." (ED doctor 1). Staff being less competent on stroke care caused continuous interruptions in the process due to the need to seek for information or advice from a more senior member from the staff before proceeding further with the decision making process. Professionals at this stage of the standardised process are assumed to be competent enough to act autonomously, without any interferes, and to make decisions for the patient based on their knowledge in order to meet the effectiveness and efficiency requirements of the process. Failure to do so, resulted in process disruptions.

Physical distance among members of professional groups constrained information exchange and development of a shared process (Radaelli, Lettieri, & Masella, 2015). For example, the ED nurses who had frequent interaction with the SNPs were observed to always inform them for the arrival of stroke patient in the ED*: "Well, sometimes as you know the ED staff do not always inform us. I do not know why this happens. It depends on the nurses. The ones who know that we are here, because they see us all the time, the communication between us is better" (SNP 3).*

Similarly, SNPs worked more efficiently with ED staff compared to the stroke doctors. SNPs had significantly more interaction with the ED staff, and consequently, were more familiar with their working approach. In contrast, the stroke doctors who were usually based in the ASU (approximately 600ms away from ED) had limited interaction with the ED staff and environment. They found it more difficult to adapt to the ED environment when they needed to go and assess the patient: *"I do not know how they work down there. It is not clear to me like in my department where I know who manages which bed all the time. That might cause issues to the communication because it is not clear with who to communicate" (Stroke Doctor).*

Professionals located closer to each other, were also observed to have better relationships than those who were located in a considerable distance from each other, which facilitated the

information exchange between them. In the hospital, when the SNPs needed to communicate with the stroke team, they called practitioners directly on their personal phone numbers, and thus communicated more quickly. In cases where the SNPs could not contact a colleague directly, they would contact an alternative member of the team whom they knew would be able to assist them. In contrast, in the event of requiring information from a colleague in a different practitioner group, the SNPs had to use the formal and highly impersonal hospital communication system (the bleep); which caused delays. For example, if there was a delay in communications between the SNP and the Bed Manager, the SNP did not have an alternative contact in the Bed Managers' team, forcing the SNP to wait for a response, creating stress and tension: *"It is more stressful when I have to locate a bed to put a patient in and I find that we do not get enough support from the site team. They do not practice, they are not active; you have to bleep them and then they do not answer the bleep. Then, I cannot leave the patient. Meanwhile I have to keep staff busy looking after the patient. I can continuously bleep the site manager and say:" you know we have a ward full of sick patients, we only have got a lady that we can move from the stroke ward so..." (SNP 3)*

Sharing dependency

The formal pathway design suggests a specific provision of resources (i.e. availability of the SNP, timely availability of CT scanner and Acute Stroke Uunit bed etc.), but in practice local resourcing, and an emphasis on resource utilisation, created barriers when multiple professional groups were involved in the process. Examples include the scanning and ED resources shared between multiple patient groups (i.e. cancer, trauma, sepsis etc.) who also needed to have their scanning completed in a critical time range. Efforts to allocate resources to all the patient groups on time, created considerable variation to the pathway, with a common consequence being unavailability of said resources.

Insert Table 1 about here

The availability of hospital resources impacted professional workloads inhibiting their ability to carry out tasks: *"it is the workload of the doctors ... they have to prioritise other things over accompanying the patient to the scanner" (ED2).* Similarly: *"...the general business of the department has an impact because if it is really, really busy and everybody is stretched in different directions you might not be able to get your patient seen by the doctor. The doctor might be doing 2 things at once"(Stoke Nurse2).* When practitioners were unable to carry out their tasks, in order to mitigate the variation and to proceed with the pathway, some tasks were undertaken by other available and eligible staff involved in the pathway, resulting in issues with their workload and process flow: *"ED nurses, sometimes if they know we go in, they do not get involved. Which is wrong because we are not supposed to go down there and take over the patients. That is not what we are supposed to do. We are very good in facilitating the pathway but, in order to do that, we have sometimes been left on our own to do the nurse's job, doctor's job - all of it. And you cannot get it all done; all the nurse's work, all the doctor's clerking and facilitate the pathway, facilitate the bed. Because 4 hours is not really long, by the time you book the scan and come back from the CT, it takes time to go through all the questions and interruptions, especially if you have very junior clerking skills" (SNP 3)*

Additionally, resources specifically dedicated to stroke care (i.e. stroke nurses and beds) were also frequently used to support the function of other hospital departments: *"Usually there are problems in finding an ASU bed. There is no bed available and you try to sort out a bed, and if there is no way to locate a bed, this will cause significant delays" (Stroke nurse).* Although practitioners and hospital managers might be aware of the impact that these actions had on the stroke care process, their main interest was to address any issue or shortage of resources in the other departments in

order to facilitate the patient flow of the hospital. Practitioners tend to utilise stroke beds in order to avoid breaching protocol in the overall organisational processes of the hospital. Similarly, picture 1 shows the staffing level of stroke nurses at the hospital on one day that the researcher was present. Because another ward was short of staff, the hospital staff manager moved one registered nurse from the ASU for the early and night shifts (assuming that the number of stroke patients arriving at the unit would be fewer during those times). However, this was not always the case and in many instances, the remaining stroke nurses were overloaded with work.

Insert picture 1 about here

Fit dependency

To control individual actions and match pathway capacity with demand, the organisation itself and care pathway modellers set a number of key performance indicators. Misalignment of the pathway targets with the other pre-existing portfolio targets and goals, induces 'quasi-competition' of the pathway with other hospital treatments and pathways for the necessary resources. Centrally, distinct targets shifted the emphasis from local delivery of care to adherence to national standards resulting in the delivery of lower quality of care. Although the common goal of the stroke care pathway was to provide good quality of care, in order to meet that goal, individuals had smaller practical system targets, (e.g. CT scan within 1-hour etc.) - based on national standards, which mainly guided their work. However, these were not aligned with the specific pathway, challenging its implementation: "*We have so many KPIs and these are conflicting" (SR1)*. Particularly, we observed that different performance requirements within the departments delivering care processes created a conflict of interest between the department which supplied the particular resource and the demanding departments' (customer) need for the use of the resource*: "ED has other competing priorities. So, in order to meet the 4hr you have to transfer the patient out of the ED to the ward.*

So, that will come ahead in theory of the stroke. So, if you look at the Government reports, they will talk about not meeting the 4hrs and being fine about it, but none cares about the stroke care pathway" (SNP 2)

Individual care professionals create variation in the care tasks and make decisions regarding which type of care is needed or is the priority, resulting in a negative effect both for the pathway (collaboration issues) and the patients: *"So, from the ED nurses the comments that you get is that: "You are not the only priority". Which proves exactly that there are multiple priorities. ED knows that stroke care is important but they do not know how to prioritise it really. That is why they need us; that is why they leave it to us." (SNP 3).*

Another observed indicator of the influence that conflicting targets and subsequent interests of each professional group had on pathway adoption was the pathway performance (mis)measurement system: *"ED staff report patient data in a different way to us. Often there are differences between the times of admissions in ED and ASU that we (stroke team) write and the ED staff do. I think this happens because they are not as interested in the time targets as we are. Or maybe they do not know, thus they are not very careful about promptly reporting the times that the admissions or treatments took place. Thus, when they remembered to do it they were not accurate" (SNP2).* Undoubtedly, such issues, challenges pathway efforts for improvement.

One approach to resolving this challenge is team working. In healthcare teamwork is defined as a dynamic process involving two or more practitioners with complementary backgrounds and skills, sharing mutual care goals for their patients, exercising rigorous physical and mental effort in patient care, making possible the best use of resources are substantial for the effectiveness and efficiency of the process (Deneckere et al., 2012). However, we observed that autonomy can challenge the efforts of professionals to work together.

Professionals and standardized work

Individual professionals - Freedom to be (dis)interested

Autonomy frequently led to minimally shared mental models of care, perspectives on the best interests of the patient, etc. and (often highly dysfunctional) competition between individuals and groups. In work studies, the idea of ''shared model'' is the development of common rules, language, and codes that are shared and well understood by all the care members involved in a given interaction (Cohendet & Llerena, 2003). None of the medical practitioners shared precisely the same understanding of the care process. Practitioners tend to have different medical and coordination understanding regarding the stroke care pathway, undermining process flow: *"I feel that some of the ED doctors do not agree with the stroke doctors. Some of the ED doctors do not tend to believe thrombolysis for stroke as such and they think it is not the best thing for the patient. It is controversial. Thus, when it comes to decision making, there are some cooperation issues there. It does not help when we want to get the treatment for the patient and they are not convinced by the data or, you know, have other concerns. This delays the process."*

Equally, there was considerable variation in the medical knowledge between them associated with their interest in stroke care. We found that compliance with the stroke care pathway was strongly associated with individual professionals' interest and knowledge: "*There are some ED doctors who are extremely good and they will manage when the patients come in as well as any stroke physician I know. But I know that they are passionate about stroke…, it depends on who is on call in the ED. Some of them will prioritise stroke and some of them will not. Some of them the stroke patient comes in but then they have some other duties to attend to, so they leave the patient to go and do something else and then come back*" (SD2). Also, stroke doctor added: *"I think again nursing wise it depends on who is on. It matters who is there, I think nurse Y who is involved in a lot of projects*

related to stroke and she is aware of what the priorities are. The level of awareness of importance and priorities of stroke is patchier for the nurses in the ED."

Conversely, when medical staff were not specifically interested or competent in stroke care, prioritisation of stroke patients was different and care was less efficient: *"Sometimes I feel that they do not see the stroke patient as such as a priority. And I have to say, 'Can you look at this patient?' Because they have different patients, different priorities. Everything is time critical, and it is difficult to switch everything on and manage everything on time especially when you have two or three patients who come in at the same time. They all have critical interventions and observations and fluids. It's very hard for them to focus on everything and do everything on time" (ED2).*

Professional to Professional

The level of practitioners' competency and commitment to stroke care also had a noteworthy impact on relational resources supporting pathway adoption. Stroke care specialists trusted and respected the professional judgments of colleagues who were more competent or more interested in stroke care, than those colleagues who were less so, and were consequently more motivated to work with them: "*So, we have got a very good relationship with Dr X. I feel very safe that we have somebody who is an advocate for stroke in ED and I think when he is there patients are given the right care. I think when he is not around, then the standard of care is a bit more variable and can affect the outcome" (SD 2).*

The impact of trust on professionals' collaboration was also noted in the instances in which the SNPs knew that the ED doctor in charge of the patient was not competent/interested in stroke care (from previous pathway experiences), they immediately contacted an ED doctor or ASU stroke doctor whom they knew to be more knowledgeable and experienced in the pathway, in order to

avoid further delays or inaccurate decision-making of the process: *"It is the ED doctor who should assess the patient, but we can also alert our stroke consultant, because our stroke doctors have more experience about thrombolysis and patient outcome than ED doctors. So, we might sometimes feel all this is tricky and we prefer to call them" (SNP2)*. This was one more verification of the positive impact that relational resources have on coordination of the process.

However, continuous disjointed collaborations between practitioners induced conflicts and tensions between them and eroded their willingness to collaborate in future. For example, there were some cases where SNPs were observed continually complaining to the researcher and amongst themselves about the failure of the ED and the RD staff to collaborate, and they sometimes spoke in an aggressive way. On one particular morning, the ED staff failed to inform the SNP of the arrival of a stroke patient, and when the SNP discovered this, became very angry. The SNP was rude and dismissive with the ED staff for the remainder of the day, complaining about their behaviour both to the ASU team and some of the ED nurses.

Frequent interactions between individuals reduced territoriality and antagonistic behaviours (Cilliers, 1998). Individuals were less judmental and more understanding and supportive towards colleagues working in close proximity to them. For example, the researchers could clearly see the compassion and understanding of SNPs towards the other members of the stroke team: "*You see one would say: "why are they not (the stroke doctors) more proactive at seeing the patients when they come in?" The trouble is their heavy workload on the ward as well. We know how they work, so we do not blame them" (SNP 2)*. And, stroke nurse said: *"I think it all depends on how you ask and you work with the staff. You have to be very mindful of their workload on this ward, we see them every day. We know how it works. ...you know you need to liaise and work with the staff. Be patient with them."* Seeing and understanding the work of colleagues at close proximity meant that

practitioners made more accurate judgements about the reasons for those colleagues' actions. This reduced the tendency for conflicts to arise between them, and additionally provided enough information and understanding about the colleagues to predict their future behaviours. This in turn enabled practitioners to accommodate variations in colleagues' performances and to support them when needed. Fitzgerald *et al*. (Fitzgerald et al., 2007) call this 'theory of mind'; "the ability of individuals to understand others' behaviours, mental states and intentions, and use this knowledge to advantage".

Professionals and standardized interactions

Variations in professionals' mental model of care can be eliminated through knowledge sharing behaviour i.e. the communication of task-relevant ideas, information and suggestions with colleagues within their organisation (Radaelli et al., 2015). As noted above, effective inter-professional collaboration had been achieved through relational resources developed via continuous interaction and knowledge sharing mechanisms. However, such interactions were moderated by pathway capacity issues (i.e. staff and bed availability, etc.). Professionals' high workload had a negative impact on the quality of their communication resulting in coordination and patient safety issues (Powell, Savin, & Savva, 2012).When professionals were busy, the exchange of administrative and medical information – important for the facilitation of the pathway – varied and created process communication issues*: "Well, sometimes as you know the ED staff do not always inform us. I do not know whether they are just so busy with the volume of work and all the sepsis patients and all the other patients that also have pre-alert pathways. You know sometimes it just slips their minds." (SNP 1).* Also, senior radiologist added: "*Sometimes there is a delay because we (the Radiographers) forgot to tell the Radiologist. When we get very busy and the communication site is lost" (SR1).* Such issues were more pronounced between individuals located

with considerable distances between them. Although, information systems were available, continuously intensive, stressful and busy environment of the healthcare setting prevented them from using information effectively and harmed communication between practitioners.

Likewise, when the stroke doctor was not available on site; the context for the exchange was different. ED staff would only call when they felt that there was a real need for advice during out-of-office-hours of care, but more importantly transferring complex information regarding a patient's medical status over the phone was not always an easy and efficient task: *"Out-of-office-hours, we might have a stroke consultant on the telephone, but sometimes it is difficult to assess the patient from the telephone..." (SNP 2).* This finding supports past research on knowledge management, arguing that physicians are reluctant to exchange information when they are confronted with practical problems in the transmission of information (Radaelli et al., 2015). Tyre *et al*. (1997) presented the concept of 'stickiness' to show the high cost of sharing information between two actors due to the tacitness of the knowledge required to exploit such information. Because of this 'stickiness', transferring such information is costly and important information may get lost through the process of transferring the information. However, communication failure among the professionals could have a negative impact not only on the efficiency (timeliness) of the process, but also effectiveness (accurate decision making) (Kc & Terwiesch, 2009)

Moreover, we observed that physical proximity between the different practitioner groups enabled the formal and informal collective process of reflection on the pathway, which is another crucial factor in process change (Edmondson, Bohmer, & Pisano, 2001). Professionals' were less motivated to attend staff meetings, especially for those who perceived the meeting place to be at a "considerable distance" from their department due to their workload and difficulties to stop what they were doing: *"…thrombolysis meetings are now taking place in our department and that makes*

it more difficult for the ED staff to engage" (SNP1). And, SD2 added: *"I was thinking, if those thrombolysis meetings were actually taking place in their department (located next to the ED medical area), that would be different. These are now taking place in our department and that makes it more difficult for them to engage."*

Process artefacts

Interaction of the pathway artefacts (physical representations of processes such as protocols, scripts, process diagrams etc.) and the different professional groups was one more manifestation of the battle between professional autonomy and standardisation of the process (Pentland & Feldman, 2008). We found that even for a single standard pathway implemented in a single hospital, there were 9 different versions of it in different forms: 4 flow diagrams, 3 scripts and a combination of script and flow diagram. Each department involved had its own protocols employed to carry out the work. Unsurprisingly, this was viewed as problematic by clinical staff, creating variation in their performances: *"We have no clear protocol shared between us which complicates our work" (SNP2).*

The diverse knowledge and understanding of professionals on stroke care was illustrated in the design of the artefacts and created miscommunications among the practitioners. We found that guidelines and protocols are most frequently developed and used by experts in each professional group, and they are used by people with varying levels of expertise (Patel, Arocha, & Kaufman, 2001). However, there were continuous inherent conflicts between the autonomy and improvisational tendencies of professionals that caused the development of alternative pathways of routine practice challenging their collaboration. Particularly, the absence of sufficiently detailed information (both medical and coordination), within the pathway documents hampered the practitioners' ability to efficiently and effectively carry out their tasks: *"There are some patients*

that have coordination problems that are not easily picked up by the medical test that we are using. So the paramedics are not alerted to their condition. And do not recognise that they have had a stroke." (ED 2).

Figure 3 below represents two of the pathway documents, each produced by members of different practitioner groups involved in delivery of the care pathway. The first diagram (A) was developed by the stroke doctor and includes a greater percentage of clinical information, explaining to practitioners how to carry out elements of the care process (i.e. take blood, repeat NIHSS score etc.).. Stroke doctor assumes that the ED practitioners are aware of the coordination routines that they should follow, thus such information is not presented in the artefacts.

While, the second diagram (B), developed by practitioners from the ED team, includes more information regarding the coordination aspects of the process, and assumes that practitioners are competent in respect of the knowledge needed to undertake clinical tasks (i.e. for thrombolysis see guidelines).. However, this was not what the researcher observed. In fact, the ED staff frequently did not know how to carry out particular coordination (i.e. handover mechanisms) and clinical tasks (i.e. thrombolysis): *"We do not have a clear defined pathway for the thrombolysis. And that makes a huge difference for the ED staff to know what to do and how to thrombolyse" (SNP 1).* Not all the ED staff knew how to thrombolyse patients and the absence of such procedural information in the process artefacts resulted in breakdowns of the care process and sever patient issues. This resulted in variations and practitioners spending more time seeking information from colleagues around them/or from the IT system in order to proceed with their tasks.

DISCUSSION AND CONCLUSIONS

Before outlining the key conclusions arising from this work, it is important to reflect on some of its limitations. Firstly, this was an exploratory study and although established literature was used

to frame the investigations, there was no formal hypothesis development or testing. The empirical setting offered the invaluable opportunity to investigate clinical care pathway implementation, but it was a case study of a single clinical care pathway in a single organisation. Several authors reinforce the limitations involved in only one case study (Eisenhardt, K.M., Graebner, 2007; Yin, 2014), since the conclusions may reduce the external validity of the study. Equally, although the research employed formal data collection protocols (triangulation, coding, etc.) derived from a conceptual framework itself informed by literature; inter-personal differences (i.e. native language, cultural assumptions, educational background, etc.) between the researchers and the participants can never be completely eliminated.

Process is more than flow

The study reinforces the observation flow dependency is a necessary but not sufficient condition for the design process logic. Designers and implementers repeatedly failed to recognise that a single treatment pathway would also be subject to other forms of dependency that would, in turn, undermine the adoption process.

The study highlights the role that professionals play in how these dependencies are managed and that they are much more than just co-ordinators or pilots(Lewis & Brown, 2012). We observe how the interaction between pathway standards and professional autonomy should be seen as an extra process dependency. Our empirical findings suggest a clear two – way split in the interaction of professionals with standardised processes. First, we distinguish the interaction of professionals with the standardised process itself (i.e. information exchange, allocation of resources etc.). Elements such as geography of the process, the associated process artefacts and hospital capacity, are not neutral and can exacerbate either of the above dynamics. All these influence the territories of professional autonomy by inhibiting and supporting interaction of professionals between them,

viewed as the second way that professionals interact with standardised work. Interactions of professionals enable knowledge sharing, development of shared model, competence, relational resources and the associated interest-motivation to engage in the process (Figure 4).

Insert figure 4 here

Professional autonomy dependency

It was interesting to observe that there is some negative and positive effect of the pathway implementation. On one hand pathways can be the vehicle for 'empire building', used to broaden specific professional span of influence and a corresponding sense of increased powerlessness on the part of those who are 'conquered'. But, on the other hand because the formal pathway is a meso construct, i.e. distinct from both the hospital (organization) and the specific professions. This allowed for clarification of role, increased (shared) understanding of personal professional value and, consequently, genuine inter-group communication.

The continuous improvement of healthcare organisations as complex and integrated systems is contingent on the deployment of the specialised knowledge held by practitioners. The nature of healthcare professionals' knowledge being tacit and made of stories regarding the knowledge of why, and how, to practice care, makes knowledge sharing difficult to manage and control from the perspective of healthcare managers (Radaelli et al., 2015). This study confirms previous findings that show that knowledge sharing does not just arise spontaneously (Radaelli et al. 2015). This study builds on the extant literature by showing how geographical fragmentation of the multiple professional groups enabled and constrained the behaviour of knowledge sharing and development of relationships amongst the healthcare practitioners. Geography of the pathway constrained the physical interactions of practitioners and hindered the development of a shared mental model. Professionals were not able to exchange information effectively and efficiently, nor were they able

to (collectively) reflect on their actions and the actions of their colleagues. Therefore, we emphasise the need to consider more carefully the flow of the process when it comes to professional work.

Relational resources of professionals were found to span organisational and spatial boundaries, encouraging knowledge sharing between practitioners and supporting the development of a shared mental model of care. Practitioners who had the opportunity to interact more frequently, and thus to develop better working and social relationships, (i.e. SNPs with the ASU stroke team) were more motivated to voice and share any issues or concerns that they had with their work. Also, professionals who share a common working environment had more and better opportunities to engage in both formal and informal conversations, and facilitated exchanges of important information for the design, implementation and delivery of care. Thus, promoting the development of initiatives where practitioners engage in formal and informal conversations is important for supporting knowledge sharing, and consequently increasing practitioner motivation to engage in efforts for pathway improvement.

Furthermore, the study shows that the artefacts of process improvement initiatives (diagrams, instruction manuals, software, etc.) can offer a critical insight into a key challenge for 'standard' (and the standardising of) professional work: individual autonomy. Autonomy with respect to specific (care) judgements is arguably the characteristic of such knowledge work but it unavoidably leads to differential interpretation (diagnoses, models of care), negotiations and consequential "turf wars". Artefacts can be a significant visual/physical manifestation of these 'zones of autonomy'. As a result, OM scholars need to move beyond a normative (this is the flow, etc.) view on process artefacts (e.g. process maps simplistically labelled 'as is' and 'to be'). To improve the development of more authentic and pertinent artefacts, the researcher suggests that hospital managers and practitioners should promote the co-design of artefacts with frontline healthcare practitioners.

Artefacts can be viewed as a type of formal contract between the modellers (hospital managers) and the practitioners who use it. Such collaboration between the practitioners and management could support operational performance in multiple directions. Firstly, this will work as a mechanism for sharing knowledge among the professionals – creating a common basis of understanding of how to carry out pathway tasks, capturing individual knowledge, goals and intentions and introducing these into the design such as to promote standardisation of the practices. Secondly, it will be an opportunity for professionals to meet, discuss and consequently develop a better understanding of the interdependent nature of their work and the associated impact of their actions on the work of colleagues. Thirdly, this collaboration would provide the opportunity for practitioners to reflect on existing processes, detect limitations and come up with improvement options. This will nullify the effects of professional autonomy, aligning practitioner and manager knowledge and objectives in support of pathway adoption and operational performance.

Sharing dependency

Specifically, one of the key challenges observed in the implementation of the stroke specific pathway was that, once deployed (or once it moved from in vitro to in vivo) it no longer existed in isolation and was confronted with the need to interact with a range of other activities and indeed other specific care pathways.

Consequently, pathways should also be conceptualised as sharing dependencies because multiple pathways are using the same resource sets (i.e scanning and ED resources) creating considerable variation to the pathway, with a common consequence being unavailability of said resources. The deployment of (physical) resources is covered in the HOM literature (Brand et al., 2005), but extant theory lacks significant explanation of how these resources are allocated and shared when they interact with multiple standardised pathways (i.e. with specific resource requirements – outside of

traditional professional judgement – for resource use). Although OM researchers have highlighted the negative impact of variability in care, this study shows that attempts to blindly implement standardised work can also create capacity issues, when autonomous professionals are involved in the process. Specifically, the findings illustrate that even if a pathway is coherent, it becomes incoherent when implemented with multiple other pathways and treatments. Autonomy frequently led to minimally shared mental models of care, perspectives on the best interests of the patient, and (often highly dysfunctional) competition between individuals and groups causing a negative effect both on its effectiveness (i.e. accuracy in decision making) and efficiency (i.e. timeliness and use of resources).

Additionally, the study highlights that in the specific setting of a publicly funded health system, the political dimension of resourcing. There is a direct connection between pathway adoption, professional responsibilities/judgements, resource competition, and consequently political dynamics. This is a potentially unstable dynamic system that is underexplored in the HOM literature. Due to the criticality of their resources for hospital performance, hospital departments involved in the care of multiple patient types, such as Radiology and Emergency departments, made decisions to use resources regardless of whether their actions were in conflict with the stroke pathway objectives (Drupsteen, van der Vaart, & Van Donk, 2016).

We contribute to the discussion on the impact of workload on team performance (Powell et al., 2012)and show that workload can have a negative impact on team productivity (Powell et al. 2012). Autonomy frequently led to minimally shared mental models of care, perspectives on the best interests of the patient, etc. and (often highly dysfunctional) competition between individuals and groups. Such issues resulted in processes break down and consequently, increase of the workload. Furthermore, we add on the discussion about the impact of psychological safety on professionals'

knowledge sharing and team performance (Siemsen, Roth, Balasubramanian, & Anand, 2009). Psychological safety relates to an employee's "sense of being able to show and employ one's self without fear of negative consequences to self-image, status, or career" (Kahn, 1990: 708). Although psychological safety among professional teams is found to enhance team collaboration and process performance, we show that professionals in an uncertain and complex context did not seem to have any feeling of shame to ask questions. But, they immediately contacted other members of the team to assist them with the process, ask for questions and advice, which resulted in considerable variations to the process. Therefore, this finding illustrates that psychological safety is highly correlated with contextual factors and would not support knowledge sharing in a context of high time pressure and urgency.

Fit dependency

Extending the discussion of shared resources to the broader question of how a hospital reconciles – or fits - all its different care pathways (explicit and implicit, formal and informal) together in a coherent way. The research confirms that such fit dependency issues were not considered in the pathway design; made manifest in a wide range of hospital KPIs, flow charts (and other artefacts) diagnostic disputes and the basic geography of the hospital creating variation to the process. For example, stroke care pathway targets and goals (e.g. Brain imaging of stroke patients within 1 hour of their arrival at the ED, admission in ASU within 4 hours and others) were in conflict with the other organisational targets and goals, thereby creating another level to the informal competition between hospital activities for the required resources (Grove, Meredith, MacIntyre, Angelis, & Neailey, 2010; Klein & Sorra, 1996). The critical managerial challenge in a fit dependency is to integrate these different 'products' into a coherent solution, but because healthcare necessarily combines the outputs from many different autonomous professionals, this limits traditional

hierarchical influence ("cat herding", etc.). Indeed, although variation and uncertainty in patients' characteristics and their impact on healthcare process and decision-making have been discussed in the HOM literature (i.e. heterogeneity in patients' characteristics - age, comorbidities etc. - underpins the need for judgement-based work) this study highlights that, in addition to such variation not being considered in formal pathway design, there are significant fit dependency consequences, in turn challenging attempts to manage a portfolio of care. Although the care pathway approach is a rational attempt to solve the flow dependency (integration) puzzle, in attempting to address the fit dependencies, there was a strong and continuous stress on performance measurement in parallel (Power, 1997) which autonomous professionals can easily undermine the game.

Suggestions for future research

Based on the findings and limitations of this study, the following suggestions appear appropriate in terms of possible future research. Firstly, replication via bigger study and trying to integrate additional data in order to verify the findings and clarify the application and significance of each finding. Secondly, this research has shown some evidence that the relationship between psychological safety and contextual factors such as time pressure and urgency (patient safety). Future research can further explore the impact of psychological safety on professionals depending on the context that work is carried out. This will help managers and professionals to identify relevant mechanisms to support or control the feeling of risks professionals have to ask questions and show their lack of knowledge and skills. Thirdly, the impact of geographical interaction/physical proximity has only received limited attention in the literature and this research, revealing its impact on efforts to standardise professional work. Future research can examine how geography of the processes support and constrain the work of individual practitioners in their

efforts to improve quality of care. Finally, the findings of this study illustrate that process artefacts play a significant role in promoting knowledge sharing, and in supporting process coordination and inter-professional collaboration. This research could analyse only archival documents, but future research might also analyse pathway artefacts in the form of software to better understand how these may constrain or promote pathway.

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Appendix

A1. Sample of data coding scheme

Variation in process dependency	**Coded theme of variation**	**Impact of variation on process dependency**			
		Flow	**Shared resources**	**Fit**	**Autonomy**
Flow *(Care) tasks occur in a specific order, with later tasks reliant on the sequence, timing and output of preceding ones*	Communication issues (time, accuracy and frequency)		ED staff do not inform stroke team for the arrival of the patient, resulting in the unavailability of the stroke specialists to ass the patient on time and continuous conflicts and tensions between them		
	Process artefacts' inefficiency		"Well, the medical test is not sufficient enough to assess when people do not have a stroke. So, the paramedics may		

			fail to recognize stroke symptoms." (ED 2)		
Shared Resources *More than one (healthcare) actor is using the same resource(s)*	Scheduling system/ Professionals' workload/ Hospital capacity	"It will just take a bit longer than if it was standard working hours, because there is less staffing at the weekend for radiographers and radiologists." (SNP2)		"I do think it is the workload of the doctors and they have to prioritise other things over accompanying the patient to the scanner" (ED2)	
Fit *Multiple activities combined together*	Professionals' relationships (i.e. trust)	"There are some ED doctors who are extremely good and they will manage when the patients come in as well as any stroke physician I know. But I know that they are passionate about stroke … they love stroke but not everybody is like that" (SD2)			"but we can also alert our stroke consultant, because our stroke doctors have more experience about thrombolysis and patient outcome than ED doctors" (SNP3)
	Shared knowledge on the process	"Sometimes the paramedics do not understand the system. We get people who			

		are from outside the area and maybe they do things differently in other places and they do not realise that they're meant to pre-alert us." (SNP2)		
Professional autonomy *Freedom to make decisions based on specialised knowledge*	Professional competence (i.e. inaccurate decision making)	"The odd patient that comes in here is not a stroke, but it is thought that they could be a stroke because out-of-office-hours staff may not have stroke expertise		
	Professional-medical interest / Conflicting process KPIs	"The ED doctor may have other conflicting things going on. For example there may be a trauma patient there which may impact his abilities to assess the patient quickly" (SNP 1)		

Figures, Pictures & Tables

Figures

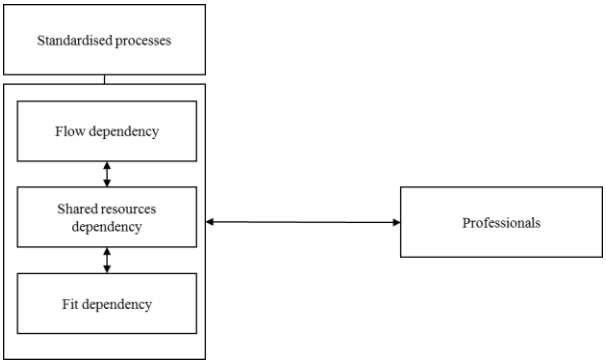


Figure 1: Conceptual model of the study

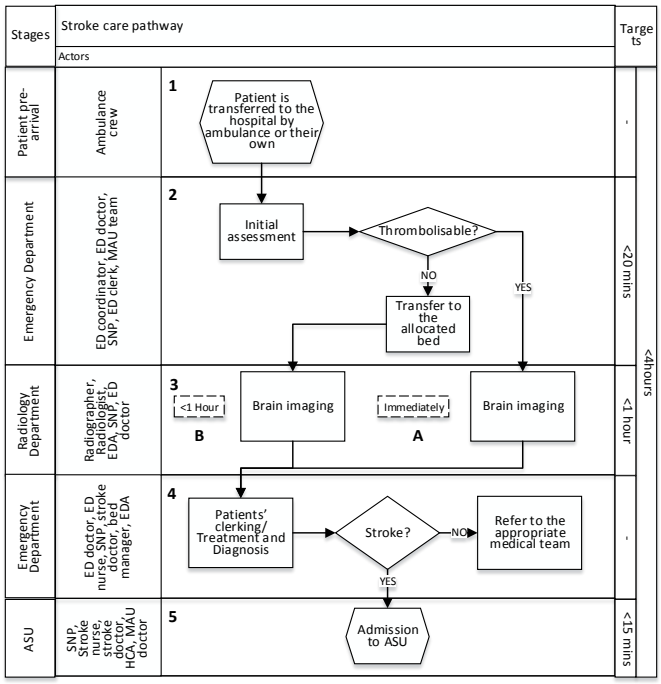
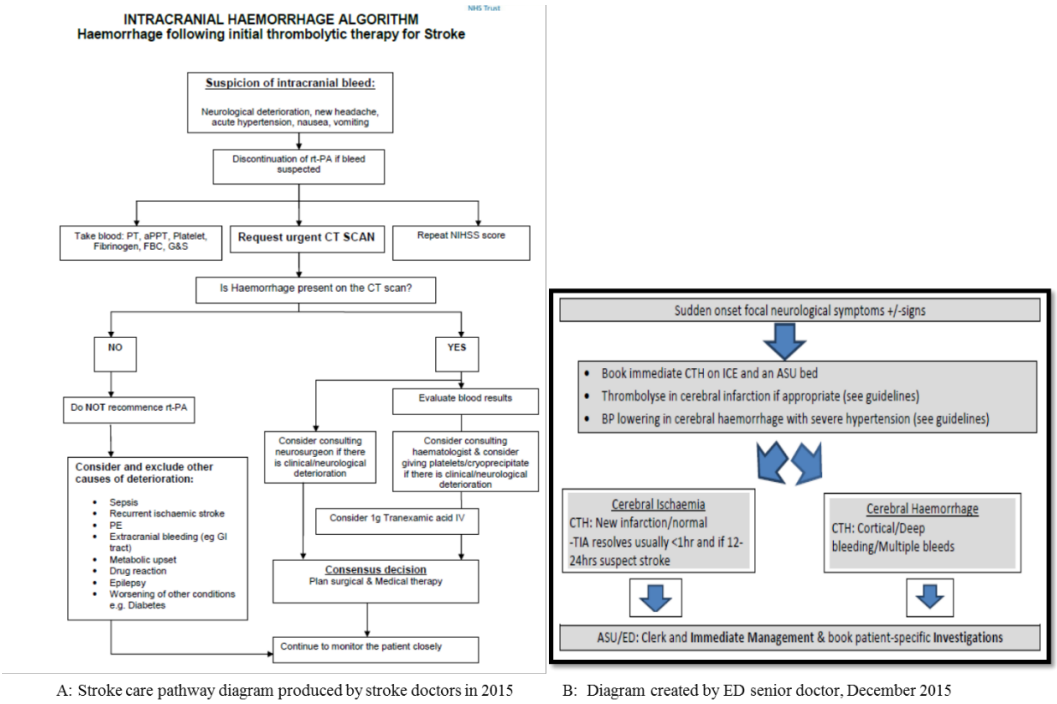


Figure 2: Stroke pathway at the hospital of study



A: Stroke care pathway diagram produced by stroke doctors in 2015 B: Diagram created by ED senior doctor, December 2015

Figure 4: Representations of the process at the hospital of study

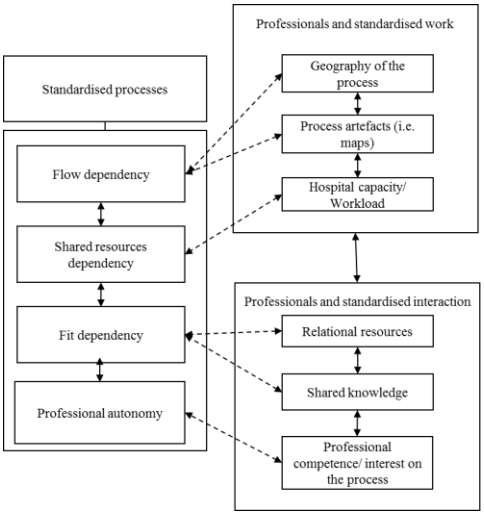


Figure 4: Revised conceptual model

Pictures

Picture 1: Staffing level of stroke nurses

Tables

Variations observed		**Impact of the variations on the process dependency**							
Type of dependency	**Coded theme of variation**	**Flow**		**Shared resources**		**Fit**		**Autonomy**	
		I/view*	**Obs***	**I/view**	**Obs***	**I/view**	**Obs***	**I/view**	**Obs***
Flow	Communication issues			8	25	3	25	4	

	Artefacts' inefficiency			5	4	7	5		
Shared Resources	Hospital capacity/ Scheduling system/ Professionals' workload	28	25			5	13	5	15
Fit	Professionals' relationships	6		5	17			5	7
	Shared knowledge on the process	6		8	16				
Professional autonomy	Professional competence (i.e. inaccurate decision making)	16		9	27	8			
	Professional-medical interest / Conflicting process KPIs	14		15		16			
I/view *= Number of Interviews that involved the relevant factor as causal factor to the variation of the process									
Obs.*= Number of cases observed that variations in the pathway were caused due to the relevant factor									

Table 1: summary of the interviews and observations made for the variation of each process dependency and their interaction